Energy, Mines and Resources Canada | Énergie, Mines et Ressources Canada

CANMET

Canada Centre for Mineral and Energy Technology | Centre canadien de la technologie des minéraux et de l'énergie

DILATATIONAL VELOCITY, YOUNG'S MODULUS, POISSON'S RATIO AND UNIAXIAL COMPRESSIVE STRENGTH FOR ATK-5 SAMPLES

R. JACKSON

ROCK MECHANICS LABORATORY

OCTOBER 1982

This document was prepared primarily for ... It does not represent a final expression of the opinion of the Canada Centre for Mineral and Energy Technology (CANMET)

... préparé ... discussion et de documentation ... ne représente nullement l'opinion définitive de l'opinion du Centre canadien de la technologie des minéraux et de l'énergie (CANMET)

ENERGY RESEARCH PROGRAM
MINING RESEARCH LABORATORIES
DIVISION REPORT ERP/MRL 82-114(TR)

CONTENTS

	Page
IDENTIFICATION OF SPECIMENS AND TESTS	1
DESCRIPTION OF TEST MEASUREMENTS	1
DATA SUMMARY	1
BASIC DATA	2

TABLES

No.		
1.	Dimensions and density of specimens	3
2.	Summary of uniaxial compressive strength dilatational velocity and deformational property data of specimens	4
3.	ATK-5 standard velocity measurements	5

FIGURES

1.	Axial and circumferential stress strain curves for ATK-5 106.5	8
2.	Axial and circumferential stress strain curves for ATK-5 224.4	9
3.	Axial and circumferential stress strain curves for ATK-5 337.5	10
4.	Axial and circumferential stress strain curves for ATK-5 424.0	11
5.	Axial and circumferential stress strain curves for ATK-5 534.2	12
6.	Axial and circumferential stress strain curves for ATK-5 625.6	13
7.	Axial and circumferential stress strain curves for ATK-5 708.7	14
8.	Axial and circumferential stress strain curves for ATK-5 818.1	15

FIGURES (cont'd)

No.		Page
9.	Axial and circumferential stress strain curves for ATK-5 867.7	16
10.	Axial and circumferential stress strain curves for ATK-5 918.2	17
11.	Axial and circumferential stress strain curves for ATK-5 951.3	18
12.	Axial and circumferential stress strain curves for ATK-5 975.6	19
13.	Axial and circumferential stress strain curves for ATK-5 1050.1	20
14.	Axial and circumferential stress strain curves for ATK-5 1107.9	21
15.	Axial and circumferential stress strain curves for ATK-5 1228.4	22

DILATATIONAL VELOCITY, YOUNG'S MODULUS, POISSON'S RATIO AND UNIAXIAL COMPRESSIVE STRENGTH FOR ATK-5 SAMPLES

by

R. Jackson*

IDENTIFICATION OF SPECIMENS AND TESTS

Mechanical property tests have been carried out on fifteen standard samples from ATK-5. Table 1 provides information on the dimensions, density and location of the fifteen specimens.

The following mechanical properties have been determined for the specimens in Table 1.

1. Dilatational velocity as a function of axial load.
2. Young's modulus and Poisson's ratio.
3. Compressive strength.

DESCRIPTION OF TEST MEASUREMENTS

Refer to Technical Data 303410-M01/78. The two Philips PR 9302 Strain Bridges and the Mosley Autograph 2FRA X-Y recorder were replaced by two Bruel and Kjaer Type 1526 Strain Indicators and a Hewlett Packard 7046B X-Y recorder to measure and record the axial and transverse strain measurements.

DATA SUMMARY

Table 2 summarizes the uniaxial compressive strength, dilatational velocity and deformational properties established for the fifteen ATK-5 specimens.

---

*Research Engineer, Atomic Energy of Canada, WNRE, Pinawa, Manitoba. Seconded to Mining Research Laboratories, CANMET, Energy, Mines and Resources Canada, Ottawa.

BASIC DATA

Figure 1 through 15 are the axial circumferential stress-strain curves from which the elastic properties of the fifteen ATK-5 specimens were determined. The final load value on the specimens was used to determine the uniaxial compressive strength.

Table 3 provides the basic data and the calculated values of dilatational velocity with uniaxial loads over the range of 0 to 70.0 KN for the fifteen specimens tested.

Table 1 - Dimensions and density of specimens

Specimen No.		Dimensions (mm)		Density
		Length	Diameter	(gm/cc)
ATK-5	106.5	97.56	44.70	2.66
ATK-5	224.4	94.62	44.45	2.66
ATK-5	337.5	95.15	44.70	2.66
ATK-5	424.0	92.71	44.86	2.66
ATK-5	534.2	95.81	44.68	2.66
ATK-5	625.6	95.73	44.88	2.68
ATK-5	708.7	95.61	44.25	2.73
ATK-5	818.1	94.72	44.81	2.65
ATK-5	867.7	96.14	44.75	2.66
ATK-5	918.2	95.73	44.83	2.65
ATK-5	951.3	96.75	44.81	2.66
ATK-5	975.6	97.21	44.35	2.66
ATK-5	1050.1	96.11	44.55	2.56
ATK-5	1107.9	96.44	44.83	2.66
ATK-5	1228.4	97.18	44.40	2.65

Table 2 - Summary of uniaxial compressive strength, dilatational velocity and deformational property data of specimens

Specimen No.	Dimensions		Young's modulus	Poisson's ratio	Compressive strength	Dilatational velocity (Vo)	Dynamic Young's modulus
	Length (mm)	Diameter (mm)	(GPa)		(MPa)	(km/sec)	(GPa)
ATK-5 106.5	97.56	44.70	96.15	0.332	242	4.759	50.25
ATK-5 224.4	94.62	44.45	98.04	0.387	229	4.865	40.40
ATK-5 337.5	95.15	44.70	64.10	0.337	224	4.757	62.54
ATK-5 424.0	92.71	44.86	71.94	0.299	241	5.328	61.84
ATK-5 534.2	95.81	44.68	60.97	0.268	212	3.943	46.97
ATK-5 625.6	95.73	44.88	62.50	0.188	235	5.012	70.52
ATK-5 708.7	95.61	44.25	57.47	0.266	206	4.148	55.02
ATK-5 818.1	94.72	44.81	54.95	0.198	178	3.835	51.55
ATK-5 867.7	96.14	44.75	61.73	0.281	202	3.924	47.76
ATK-5 918.2	95.73	44.83	59.52	0.250	217	3.915	49.99
ATK-5 951.3	96.75	44.81	97.09	0.359	223	4.216	39.72
ATK-5 975.6	97.21	44.35	59.88	0.229	208	3.790	49.05
ATK-5 1050.1	96.11	44.55	63.29	0.251	217	3.718	52.23
ATK-5 1107.9	96.44	44.83	56.98	0.308	185	4.035	46.03
ATK-5 1228.4	97.18	44.40	70.77	0.223	293	4.695	65.08

Table 3 - ATK-5 standard velocity measurements

Load (KN)	ATK-5 106.5 T_p (μsec)	ATK-5 106.5 V_p (km/sec)	ATK-5 224.4 T_p (μsec)	ATK-5 224.4 V_p (km/sec)	ATK-5 337.5 T_p (μsec)	ATK-5 337.5 V_p (km/sec)	ATK-5 424.0 T_p (μsec)	ATK-5 424.0 V_p (km/sec)	ATK-5 534.2 T_p (μsec)	ATK-5 534.2 V_p (km/sec)
0	20.50	4.76	19.45	4.86	20.00	4.76	17.40	5.33	24.30	3.94
5.0	20.40	4.78	18.90	5.01	19.65	4.84	17.35	5.34	23.75	4.03
10.0	19.85	4.91	18.40	5.14	19.40	4.91	17.30	5.36	23.15	4.14
15.0	19.45	5.02	17.90	5.29	19.00	5.01	17.15	5.41	22.35	4.29
20.0	19.00	5.13	17.55	5.39	18.80	5.06	17.00	5.45	21.65	4.43
25.0	18.65	5.23	17.40	5.44	18.55	5.13	16.90	5.49	21.00	4.56
30.0	18.35	5.32	17.25	5.48	18.30	5.20	16.70	5.55	20.60	4.65
35.0	18.05	5.40	17.05	5.55	18.00	5.29	16.60	5.58	20.05	4.79
40.0	17.95	5.44	16.95	5.58	17.80	5.35	16.40	5.65	19.70	4.86
45.0	17.70	5.51	16.80	5.63	17.55	5.42	16.30	5.69	19.40	4.94
50.0	17.55	5.56	16.70	5.67	17.45	5.45	16.20	5.72	19.10	5.02
55.0	17.45	5.59	16.70	5.67	17.25	5.52	16.15	5.74	18.85	5.08
60.0	17.35	5.62	16.65	5.68	17.10	5.56	16.00	5.79	18.50	5.18
65.0	17.20	5.67	16.60	5.70	16.85	5.65	15.90	5.83	18.40	5.21
70.0	17.15	5.69	16.60	5.70	16.85	5.65	15.90	5.83	18.15	5.28
	$\overline{V}_p$ = 5.31		$\overline{V}_p$ = 5.67		$\overline{V}_p$ = 5.25		$\overline{V}_p$ = 5.58		$\overline{V}_p$ = 4.69	

Table 3 - Cont'd

Load (KN)	ATK-5 625.6 T_p (μsec)	ATK-5 625.6 V_p (km/sec)	ATK-5 708.7 T_p (μsec)	ATK-5 708.7 V_p (km/sec)	ATK-5 818.1 T_p (μsec)	ATK-5 818.1 V_p (km/sec)	-5 867.7 T_p (μsec)	-5 867.7 V_p (km/sec)	ATK-5 918.2 T_p (μsec)	ATK-5 918.2 V_p (km/sec)
0	19.10	5.01	23.05	4.15	24.70	3.83	24.50	3.92	24.45	3.92
5.0	19.00	5.04	22.55	4.24	23.75	3.99	23.70	4.06	23.50	4.07
10.0	18.70	5.12	21.85	4.38	22.70	4.17	22.95	4.19	22.55	4.25
15.0	18.55	5.16	21.20	4.51	22.15	4.28	21.75	4.42	21.80	4.39
20.0	18.35	5.22	20.70	4.62	21.60	4.39	20.80	4.62	21.25	4.51
25.0	18.10	5.29	20.30	4.71	20.90	4.53	20.25	4.75	20.70	4.62
30.0	17.85	5.36	19.75	4.84	20.50	4.62	19.55	4.92	20.20	4.74
35.0	17.70	5.41	19.40	4.93	19.95	4.75	19.20	5.01	19.75	4.85
40.0	17.55	5.45	19.15	4.99	19.60	4.83	18.85	5.10	19.40	4.93
45.0	17.35	5.52	18.90	5.06	19.30	4.91	18.80	5.11	19.15	5.00
50.0	17.20	5.57	18.60	5.14	19.10	4.96	18.55	5.18	18.85	5.08
55.0	17.15	5.58	18.50	5.17	18.90	5.01	18.40	5.22	18.60	5.15
60.0	17.00	5.63	18.45	5.18	18.65	5.08	18.25	5.27	18.35	5.22
65.0	16.90	5.66	18.35	5.21	18.60	5.09	18.15	5.30	18.15	5.27
70.0	16.70	5.73	18.20	5.25	18.40	5.15	18.05	5.33	18.00	5.32
	$\overline{V}_p$ = 5.38		$\overline{V}_p$ = 4.82		$\overline{V}_p$ = 4.64		$\overline{V}_p$ = 4.83		$\overline{V}_p$ = 4.75	

Table 3 - Cont'd

	ATK-5 951.3		ATK-5 975.6		ATK-5 1050.1		ATK-5 1107.9		ATK-5 1228.4	
Load (KN)	T_p (μsec)	V_p (km/sec)	T_p (μsec)	V_p (km/sec)	T_p (μsec)	V_p (km/sec)	T_p (μsec)	V_p (km/sec)	T_p (μsec)	V_p (km/sec)
0	22.95	4.22	25.65	3.79	25.85	3.72	23.90	4.04	20.70	4.69
5.0	22.20	4.36	24.75	3.93	24.75	3.88	23.20	4.16	20.30	4.79
10.0	21.50	4.50	23.85	4.08	23.35	4.12	22.25	4.33	19.95	4.87
15.0	20.80	4.65	22.90	4.24	22.00	4.37	20.90	4.61	19.40	5.01
20.0	20.15	4.80	22.20	4.38	21.00	4.58	20.70	4.66	18.90	5.14
25.0	19.70	4.91	21.65	4.49	19.90	4.83	20.15	4.79	18.50	5.25
30.0	19.15	5.05	21.15	4.60	19.60	4.90	19.70	4.90	18.20	5.34
35.0	18.95	5.11	20.60	4.72	18.95	5.07	19.35	4.98	17.90	5.43
40.0	18.70	5.17	20.25	4.80	18.75	5.13	18.95	5.09	17.80	5.46
45.0	18.50	5.23	19.90	4.88	18.45	5.21	18.60	5.19	17.60	5.52
50.0	18.25	5.30	19.60	4.96	18.10	5.31	18.50	5.21	17.50	5.55
55.0	18.10	5.35	19.35	5.03	17.90	5.37	18.25	5.28	17.40	5.59
60.0	17.95	5.39	19.15	5.08	17.70	5.43	18.10	5.33	17.25	5.63
65.0	17.65	5.48	19.00	5.12	17.55	5.48	17.90	5.39	17.15	5.67
70.0	17.60	5.50	18.65	5.21	17.40	5.52	17.70	5.45	17.05	5.70
	$\overline{V}_p$ = 5.00		$\overline{V}_p$ = 4.62		$\overline{V}_p$ = 4.81		$\overline{V}_p$ = 4.89		$\overline{V}_p$ = 5.31	

Fig. 1 - Axial and circumferential stress strain curves for AISI-5 106-5

Fig. 2.7 Axial and circumferential stress strain curves for AIN-5 224.4

KEUFFEL & ESSER CO. MADE IN U.S.A.
46 1513

FIG. 3 - Axial and circumferential stress strain curves
FOR ATK-5 3.17.15

KOE 10 X 10 TO THE CENTIMETER 46 1513
KEUFFEL & ESSER CO. MADE IN U.S.A.

Fig. 4 - Axial and circumferential stress strain curves for ATK-5 422-Q

Fig. 5 T-Axial and circumferential biaxial strain curves for AIR-5 5154-2

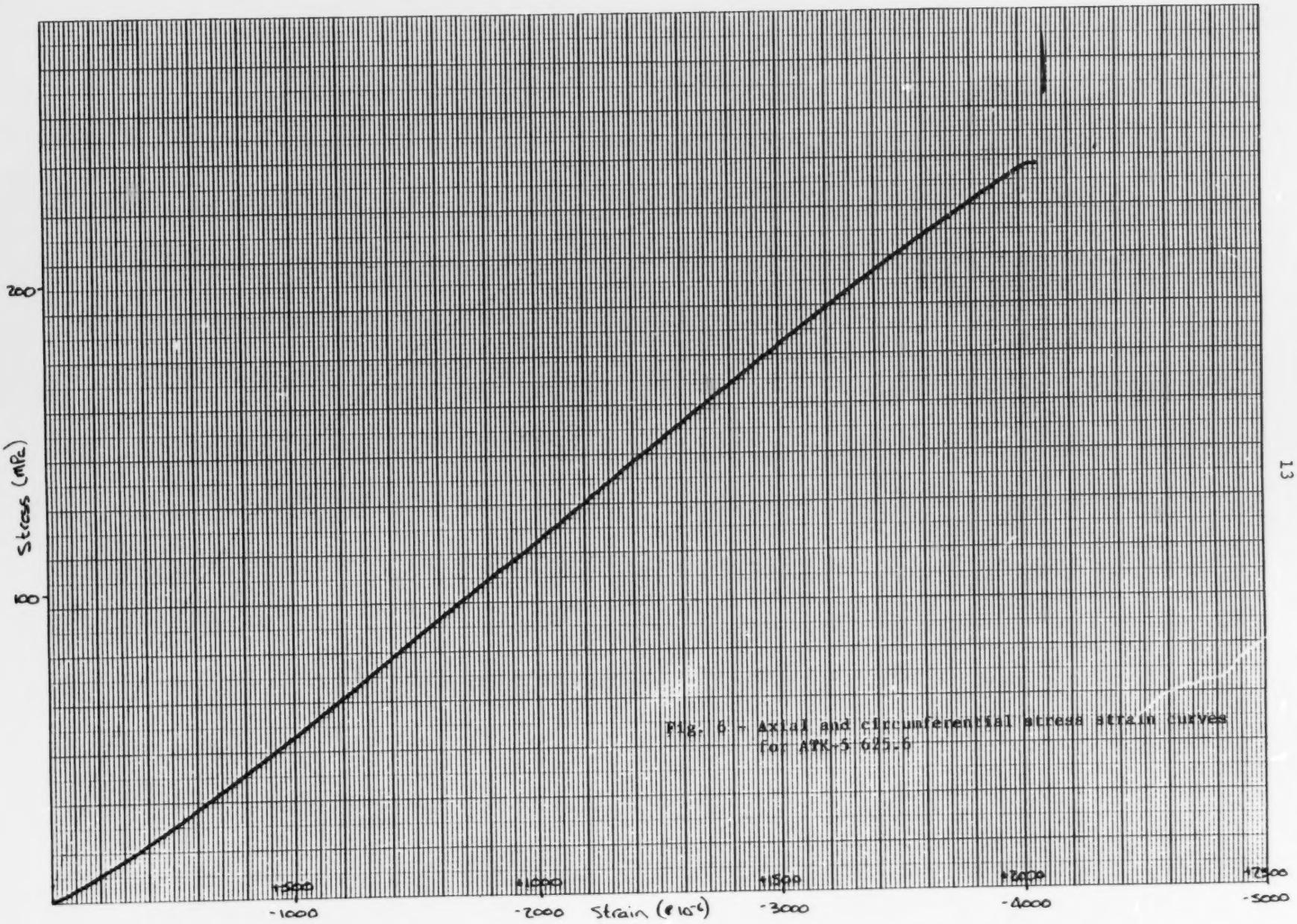

Fig. 6 - Axial and circumferential stress strain curves for ATK-5 625-6

46 1513
KEUFFEL & ESSER CO. MADE IN U.S.A.
10 X 10 TO THE CENTIMETER

Stress (MPa)
80
60
-1000
-2000
-3000
-4000
-5000
Strain (*10⁴)
Fig. 7 - Axial and circumferential stress strain curves for AIK-S 708.7
KE 10 X 10 TO THE CENTIMETER
KEUFFEL & ESSER CO.
46 1513

Stress (MPa)
200
100
-1000
-2000
-3000
-4000
-5000
Strain (μ10⁻⁶)
46 1513
K&E 10 X 10 TO THE CENTIMETER
FIG. 4 - Axial and circumferential stress-strain curves
for AMR-5 8181

Stress (ksi)
200
100
0
1000
2000
3000
4000
5000
Strain (μin/in)
Fig. 8 - Axial and circumferential stress strain curves
for A1K-5 867.7
K&E 10 X 10 TO THE CENTIMETER
46 1513

Fig. 10 - Axial and circumferential stress-strain curves for AMS 9182

Stress (MPa)
200
100
Strain (με)
4000
3000
2000
1000
0
Ti-15Mo-5Zr-3Al
Aged at 482°C (900°F) for 24 hours
Tensile stress-strain curve
Test specimen diameter = 12.7 mm (0.5 in.)
Gage length = 50.8 mm (2.0 in.)
Strain rate = 0.005 mm/mm/min (0.005 in./in./min)
46 1513
KE 10 X 10 TO THE CENTIMETER
KEUFFEL & ESSER CO. MADE IN U.S.A.

Fig. 12 - Axial and circumferential stress strain curves for ATK-S 975-6

Stress (MPa)
200
100
-1000
-2000
-3000
-4000
-5000
Strain (*10^-6)
Fig. 11 - Axial and circumferential stress strain curves for AIK-3 1050°F

46 1513

Fig. 14 - Axial and circumferential strain gage strain curves for AIK-5 1107.9

K·E 10 X 10 TO THE CENTIMETER
46 1513

Stress (MPa)
200
100
-1000
-2000
-3000
-4000
-5000
Strain (x 10⁻⁶)
Fig. 15 - Axial and circumferential stress-strain curves
for ATK-5 1228.4
KE
10 X 10 TO THE CENTIMETER
46 1513